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# Outcome of noncardiac surgery in children with congenital heart disease performed outside a cardiac center

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ABSTRACT

*Objective:* The objective of this study was to review the outcome of children with congenital heart disease (CHD) undergoing noncardiac surgery requiring general anesthesia (GA) in a tertiary pediatric center between January 2010 and December 2012.

*Study design:* A retrospective case note review of children <16 years of age with confirmed CHD undergoing a surgical or interventional procedure requiring GA was performed. Patients were categorized into three risk groups according to White and Peyton's anesthetic risk classification of children with CHD undergoing noncardiac surgery [*Critical Care and Pain* 2012;12:17–22].

*Results:* 117 children with CHD were identified with a total of 240 procedures conducted. 36 procedures were conducted in the high-risk group, 135 in the intermediate-risk group, and 69 in the low-risk group. 40% of these were major operations such as small bowel and colonic procedures. Overall mortality rate at 7 days and 30 days was 0% and 0.4%, respectively, with a 1% mortality rate in minor procedures and 0% mortality rate in major procedures. There were no unexpected deaths. 17% of procedures resulted in complications. A higher rate of complications was recorded in emergency procedures. 17% of these procedures required admission to the intensive care unit, with the highest admissions rate in the high-risk group. The median duration of hospital stay for the whole cohort was 1 day (range of 0–71 days).

*Conclusion:* Our study shows that procedures requiring GA can be safely conducted on children from any of the three risk groups in a nonspecialist cardiac center provided that there is close liaison and careful planning between the different specialties.



Congenital heart disease (CHD) is the most common birth defect, occurring in approximately 1 in 125 live births [1]. Of these, about 30% require surgery within the first year of life for extracardiac anomalies such as tracheoesophageal fistula, anorectal anomalies, cleft lip and cleft palate [2]. In addition, the neonatal course of some of these infants may be further complicated by other conditions associated with prematurity such as necrotizing enterocolitis, requiring emergency surgery. Furthermore, >85% of children with CHD are surviving to adulthood, presenting clinicians with further challenges as they are subject to the same childhood illnesses as healthy children and may present to local hospitals requiring elective and emergency surgery [3]. A diagnosis of CHD increases short-term and long-term mortality risk for major and minor noncardiovascular procedures and risk of other complications and previous studies have highlighted a number of associated risk factors (Table 1) [4].

In view of the increased risk of mortality and morbidity, there is debate over whether surgery in children with CHD should be conducted in local hospitals or specialist cardiac centers. The "Safe and Sustainable Review of Children's Congenital Heart Services" reported concerns over standard of perioperative care [5]. It was suggested that children requiring surgery should travel to a specialist center where there was more specialist cardiac anesthetic expertise. So it should be the availability of high quality care which should take precedence over travel times and the location of the center. However, others have highlighted the potential problems of increased travel time and psychological distress to patients and their families.

There is currently no evidence that outcome of general (noncardiac) surgery in children with CHD performed at specialist centers lowers the risk of mortality and morbidity compared to local pediatric surgical departments with the appropriate anesthetic and pediatric skills. The aim of this study was to review the outcome of children with CHD undergoing noncardiac surgery outside a cardiac center, in a hospital with pediatricians with expertise in cardiology (PEC) working closely with pediatric anesthetists, surgeons and intensivists.

## 1. Methods

Children <16 years of age that underwent an interventional procedure requiring general anesthesia (GA) between 2010 and 2012 were

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**Table 1**
Risk stratification of children with CHD undergoing noncardiac surgery [4].

| High Risk | Intermediate Risk | Low Risk |
|---|---|---|
| Physiologically poorly compensated and/or presence of major complications:<br>(a) Cardiac failure<br>(b) Pulmonary hypertension<br>(c) Arrhythmias<br>(d) Cyanosis | Physiologically normal or well compensated | Physiologically normal or well compensated |
| • Complex lesions (single ventricle or balanced circulation physiology, cardiomyopathy, aortic stenosis) | • Simple lesions | • Simple lesions |
| • **Major surgery** (intraperitoneal, intrathoracic, anticipated major blood loss requiring transfusion) | • **Major surgery** (intraperitoneal, intrathoracic, anticipated major blood loss requiring transfusion) | • **Minor (or body surface) surgery** |
| • <2 years old<br>• Emergency surgery<br>• Preoperative hospital stay >10 days | • <2 years old<br>• Emergency surgery<br>• Preoperative hospital stay >10 days | • 2 years old<br>• Elective surgery<br>• Preoperative hospital stay <10 days |

identified from the database at a tertiary pediatric center. Interventional procedures include both surgical and invasive diagnostic procedures. Patients attending any PEC clinics between 2008 and 2012 were identified using the hospital coding system. These two selection criteria were used and children were excluded if they had a normal echocardiogram report or were discharged from the PEC clinic with a normal heart. The term 'congenital heart disease' includes structural heart defects, arrhythmias and cardiomyopathies.

A retrospective case note review was performed. Four main outcomes were studied — mortality, postoperative complications, admission to the Pediatric or Neonatal Intensive Care Units (PICU or NICU) and the duration of hospital stay. These outcomes were explored according to the risk groups listed in Table 1. Statistical analysis was conducted using the chi-squared test. Data are quoted as median (range). $P < 0.05$ was considered statistically significant.

## 2. Results

18,386 children who had undergone an intervention requiring GA were identified from the hospital database. Among this, 503 (3%) patients had attended a PEC clinic between 2008 and 2010, 117 (0.6%) of which underwent a noncardiac intervention under GA. Fig. 1 illustrates the study flow chart.

A cohort of 117 children with a diagnosis of CHD was identified; with 75 (64%) of these <2 years of age. Acyanotic conditions were the most common category of CHD, featuring in 75 (64%) patients; 18 (15%) had valvular disease and 13 (11%) had cyanotic heart disease. Another 11 children (9.4%) had other diagnoses such as arrhythmias and cardiomyopathies.

240 interventional procedures were conducted in 117 children. 224 of these procedures were surgical with the remaining 16 for diagnostic purposes. According to risk stratification, there were high risk (HR) (n = 36); intermediate risk (IR) (n = 135) and low-risk groups (LR) (n = 69). 202 (84%) procedures were elective procedures and 38 (16%) were conducted in an emergency setting. 151 (63%) of these procedures were conducted in children <2 years, of which 32 (21%) were emergency procedures (Table 2).

A wide range of procedures was conducted over this period, with 101 (42%) of procedures classified as major operations i.e. intrathoracic or intraabdominal surgeries. The most common procedures performed were gastrointestinal (small bowel procedures, colonic procedures, fundoplication and tracheoesophageal fistula repair) and plastic surgeries (cleft lip/palate repair, pollicisation and pharyngoplasty) (Table 3).

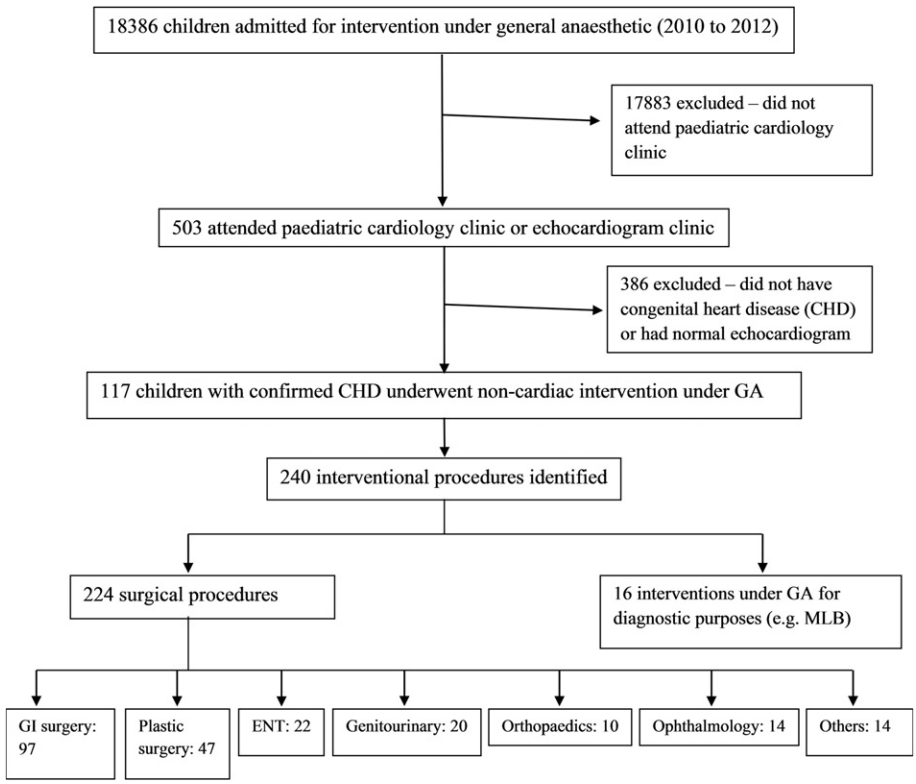


**Fig. 1.** Flow chart detailing patient selection.